RESEARCH DEPARTMENT

Control of the picture display in colour film recording equipment

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THE BRITISH BROADCASTING CORPORATION
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CONTROL OF THE PICTURE DISPLAY IN COLOUR FILM RECORDING EQUIPMENT

SUMMARY

A technique for adjustment of the picture-display parameters in a colour film telerecording equipment is described. A photometric method of determining the correct cathode-ray tube adjustments for low picture-brightness values is used, in conjunction with a white-level clamping circuit, which enables these adjustments to be made without affecting the displayed peak brightness.

1. INTRODUCTION

In the colour picture-display equipment developed for use in colour film recording[1] the following parameters require accurate control:

(a) The balance of the light output from the three channels, so that an overall colour-cast does not appear in the recorded picture.

(b) The 'tracking' of the light output between the channels, relative to each other, so that a neutral reproduction of achromatic scenes over the whole light-input range is obtained.

(c) The brightness of each channel corresponding to both white and 'picture-black,'* so that operation over the correct part of the film characteristic is achieved.

In each channel, control of two variables (video gain and the grid-cathode bias potential of the cathode-ray tube) is available to carry out the above adjustments. There are thus two degrees of freedom possible for the adjustment of each channel, and the brightness levels corresponding to two (and only two) input video-signal levels can be independently defined. It is usual to choose white and picture-black for these brightness levels as the adjustment of these parameters in each channel defines the exposure range of each dye-forming layer in the colour film. A convenient procedure for adjusting the white brightness is to apply a video signal corresponding to white and to adjust the mean cathode current of the cathode-ray tube in each channel to a pre-determined value. This procedure cannot, however, be used for setting the picture-black brightness level, because the low value of beam current is then comparable with leakage currents within the cathode-ray tube, and the measurement of cathode current no longer provides an accurate measure of tube brightness. In this case the adjustment is best carried out by photometric measurement* using a displayed picture containing areas both of low brightness and of white, the latter being used as a reference of colour and brightness.

In a display system using conventional black-level clamping, the adjustment of black level affects the white-display conditions and the correct control settings have therefore to be approached by means of successive adjustments of the gain and black-level controls. The necessity for the continual re-adjustment of the white-display conditions in order to preserve the correct 'reference' colour and brightness is avoided by the use of the white-level clamping technique described in the next section. This technique enables the adjustment of the black-level display conditions to be made without affecting the white-level conditions, and the setting-up procedure is thus greatly simplified.

* It is usual to arrange that the telerecording display has a small but finite brightness in areas corresponding to black in the original picture, in order to avoid loss of detail in very dark areas of the recorded picture due to 'exposure inertia' of the film.

* See Section 3.

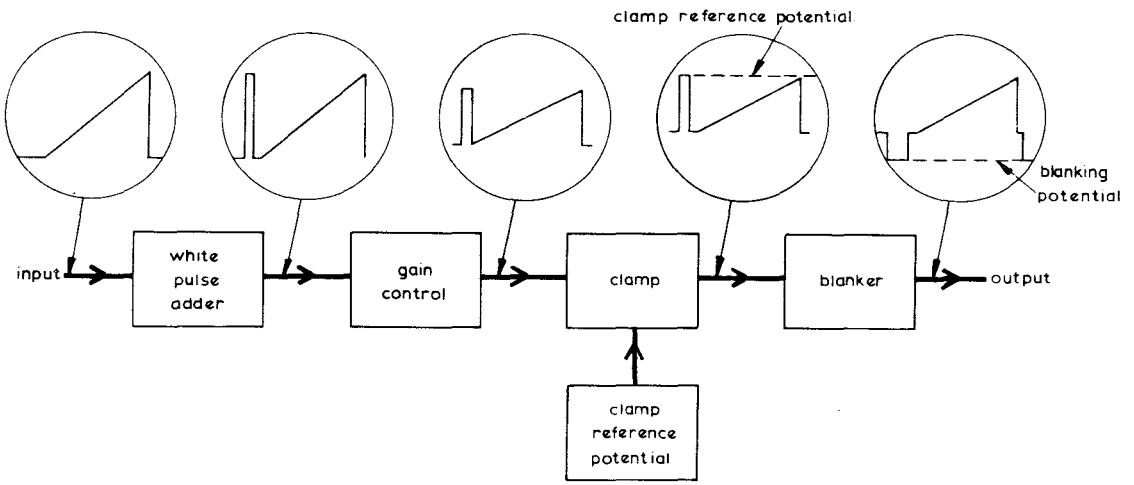

Fig. 1 - Block diagram of white-level clamping circuit. Waveforms occurring at various points are shown in circles

2. THE WHITE-LEVEL CLAMPING TECHNIQUE

A block diagram of the white-level clamping circuit is shown in Fig. 1. A 'white' pulse equal in height to the nominal black-to-white signal transition is added to the incoming video signal (shown as a sawtooth waveform) in the line-blanking interval. The resulting composite signal is then supplied, by way of variable gain control, to a clamping circuit which refers the tip of the pulse to the clamp-reference potential. A further circuit then removes the pulse and returns the video signal, during the blanking intervals, to a fixed potential (the blanking potential) in relation to which adjustment of the clamp-reference potential is made.

The effects of adjusting the clamp-reference potential and gain controls in the white-level clamping circuit are shown in Fig. 2. For descriptive convenience, an incoming video waveform (Fig. 2(*a*)) consisting of a slow transition between picture black-level and white-level is assumed. In the white-level clamping circuit the blanking potential is arranged to be more negative than the picture black-level potential, so that the waveform leaving the circuit (Fig. 2(*b*)) contains negative-going pulses during the blanking interval. The potentials in the cathode-ray tube drive circuits are arranged so that, in the blanking interval, the beam current is completely cut off. The effect of adjusting the clamp reference potential is shown by the arrows in Fig. 2(*c*), the potentials of all levels of the video waveform (relative to the blanking potential) being equally affected. Adjustment of the gain control (Fig. 2(*d*)) alters the potentials of the video levels to an increasing extent as picture black-level is approached, white-level being unaffected; thus, when this signal is again clamped in the cathode-ray tube drive circuit, the light output from white picture areas remains constant while the display brightness corresponding to picture black-level is adjusted. It should be emphasized that, because the height of the pulse in the white-level clamping circuit is pre-set to the nominal white-signal amplitude of the incoming video signal and does not

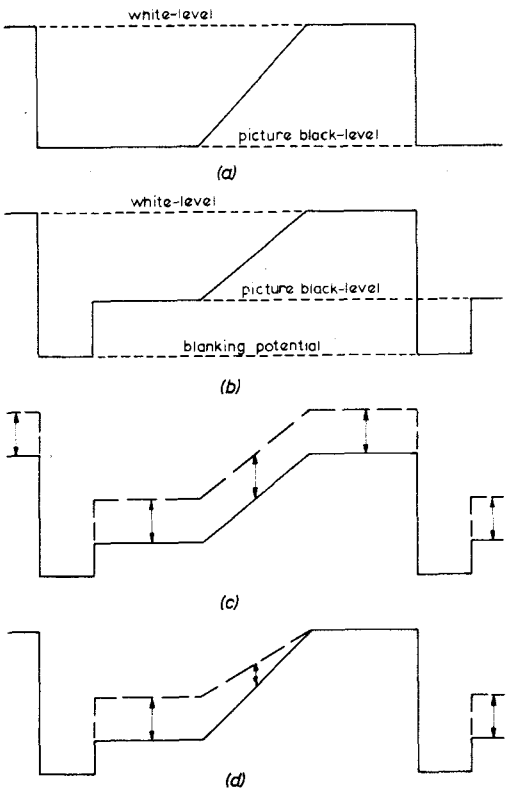

Fig. 2 - Effect of adjustments in white-level clamping circuit

(*a*) incoming video waveform
(*b*) output from white-level clamping circuit
(*c*) effect of adjusting clamp-reference potential
(*d*) effect of adjusting gain control

depend on the actual white-level of the video signal, incoming signals exceeding the white-signal level will be reproduced on the cathode-ray tube with enhanced brightness in the normal manner.

Although the adjustment of the clamp-reference potential control affects the brightness of both white and picture-black areas of the cathode-ray tube display, no operational convenience is lost by this interaction since this control is used first for setting the white display brightness in each channel to the correct value.

3. PHOTOMETRIC ADJUSTMENT OF PICTURE-BLACK DISPLAY BRIGHTNESS

A photometric comparison between the white and dark-area brightnesses of each cathode-ray tube of the colour picture-display equipment can be made, in turn, by arranging that an area of the cathode-ray tube at peak brightness is viewed through a neutral absorption-type filter, while an immediately adjacent area of low brightness is viewed directly. Ideally the comparison should be made between areas of white and picture-black level, as discussed in Section 1. The light level obtained for picture black may however be too low for an accurate photometric comparison to be made, necessitating the use of a low-level video signal in the low-brightness picture area.

A practical optical arrangement for obtaining the necessary split field-of-view is shown in Fig. 3. A real image of the displayed picture is formed in the plane ABC, the portion AB corresponding to the white area and the portion BC to the low-brightness area. A separate lens may be used for this purpose; alternatively, the film camera lens may be used by inserting the photometer into the film gate of the camera. The photometric cube P is arranged so that when looking into the surface XY, the white area is seen in the reflecting portions R1 and R2 of the interface by way of the mirror M* and the neutral density filter D, while the low-brightness area is seen inset into this image through the transmitting portion of the cube T. The eyepiece lens L forms a magnified virtual image of the interface of the photometric cube. The focal length of the lens L should not be similar to the path-length from L to either portion (AB or BC) of the real image of the displayed picture. Similarity of these lengths would cause the image of AB (or BC) as viewed through L to be magnified, and brightness discontinuities in the image (for example, scanning lines) would also be magnified and could then have a significant

* In practice this could take the form of a right-angled totally-internally-reflecting prism.

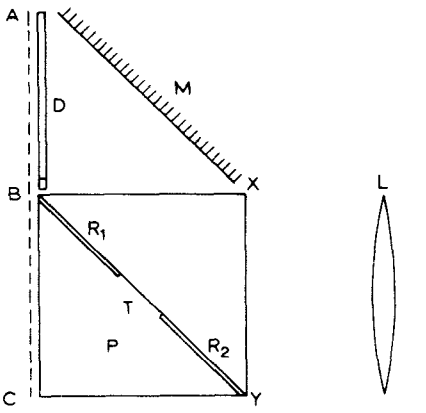

Fig. 3 - Optical arrangement for display brightness photometer

ABC real image of displayed picture
AB white area
BC low-brightness area
P photometric cube
R_1, R_2 reflecting portions of interface
T transmitting portion of interface
D neutral density filter
M mirror
L eyepiece lens

effect on the relative brightnesses of the two parts of the image. The density* of the absorption filter D (Fig. 3) is chosen (in conjunction with the video-signal magnitude, which determines the brightness of the dark-display area) so that the two parts of the split field-of-view appear to be equally bright when the correct ratio between white brightness and picture-black displayed brightness** is achieved. Assuming that the white brightness has already been set to its correct value by adjustment of the clamp-reference potential control in the white-level clamping circuit (see Section 2), the picture-black displayed brightness can be set by adjustment of the gain control. In practice it has been found convenient to adjust the picture-black operating point of the cathode-ray tube in each channel in turn using this technique and then to make final small adjustments with all channels in operation until the colours and luminances of the two parts of the split field-of-view are identical, as seen by the disappearance of the boundary between the two parts of the split field.

The colour balance of the picture produced by the telerecording picture-display equipment is adjusted to give correct picture reproduction on the film stock used as the recording medium. This balance will not necessarily be correct for visual

* The reflection coefficient of the mirror or prism M (Fig. 3) must also be taken into account; furthermore, the filter must be accurately neutral.

** See foot-note on page 1, Col. 1.

observations and use may be made of a colour-correction filter, the characteristics of which will depend on the particular film stock in use. The characteristic required in conjunction with Eastman negative film stock type 5251 may be obtained by the use of a combination of Wratten colour-correcting filters of types 80C and 30B. The white point of the picture-display when viewed through this filter combination approximates closely to Illuminant 'C'.

4. CONCLUSIONS

The operational procedure required to obtain tracking of the picture-display of a colour film recorder is considerably simplified by the use of a white-level clamping technique, in conjunction with a photometric method of determining the display brightness corresponding to picture-black level. The incorrect colour balance seen when the picture display is observed visually can be corrected by the use of a suitable absorption-type filter pack.

5. REFERENCE

1. The specification of colour sensitometric parameters in colour film telerecording. BBC Research Department Report No. T-182, Serial No. 1966/69.

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